

Historic, archived document

Do not assume content reflects current
scientific knowledge, policies, or practices

ASD 11
U593

STA

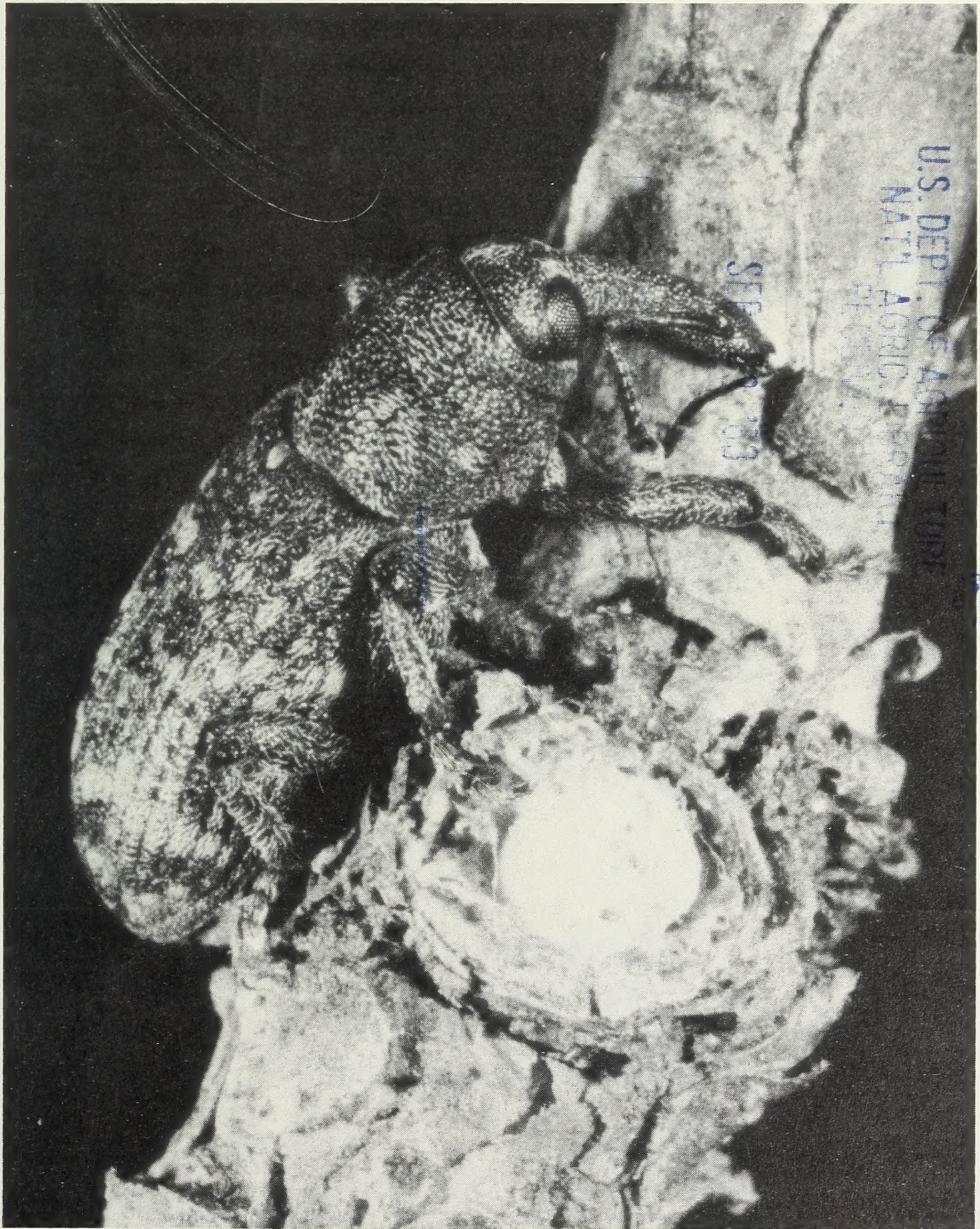
(~~2077~~) Reserve

United States
Department of
Agriculture

Forest Service
Southern Region



Control of Pales and Pitch-Eating Weevils in the South



USDA Forest Service
Southeastern Area
1720 Peachtree Road N.W.
Atlanta, Georgia 30367

Research
Station, Re
Entom
Asheville, N
Staff
and Comm

Control of Pales and Pitch-Eating Weevils In the South

John C. Nord¹

John H. Ghent²

Hollis A. Thomas¹

Coleman A. Doggett³

¹ Research Entomologists, USDA Forest Service, Southeastern Forest Experiment Station, Research Triangle Park, N.C.

² Entomologist, USDA Forest Service, Southeastern Area, Forest Pest Management, Asheville, N.C.

³ Staff Forester (Pest Control), North Carolina Department of Natural Resources and Community Development, Division of Forest Resources, Raleigh, N. C.

TABLE OF CONTENTS

Introduction	1
Historical Background	2
Range and Hosts	3
Biology	4
Identifying Hazardous Sites	8
Hazard Rating	8
Nonhazardous Sites	9
Hazardous Sites	10
Guide to Determining Weevil Damage Hazard	10
Control Alternatives	11
Delayed Planting	11
Chemical Control	11
Chemical Control Strategy	12
Preventing Large Population Buildups	14
Appendix	15
Chemical Control Alternatives	15
References	22

INTRODUCTION

Forest managers strive to replant harvested sites at the first opportunity, usually during the winter following the cut. A delay in regeneration will lengthen the rotation 1 or more years, resulting in a proportional loss of production; and it may increase site preparation costs or vegetative competition. However, forest managers who replant pine sites soon after harvest often face the threat of high seedling mortality due to girdling by pales weevil, *Hylobius pales* (Herbst), and pitch-eating weevil, *Pachylobius picivorus* (Germar) (figures 1,2).

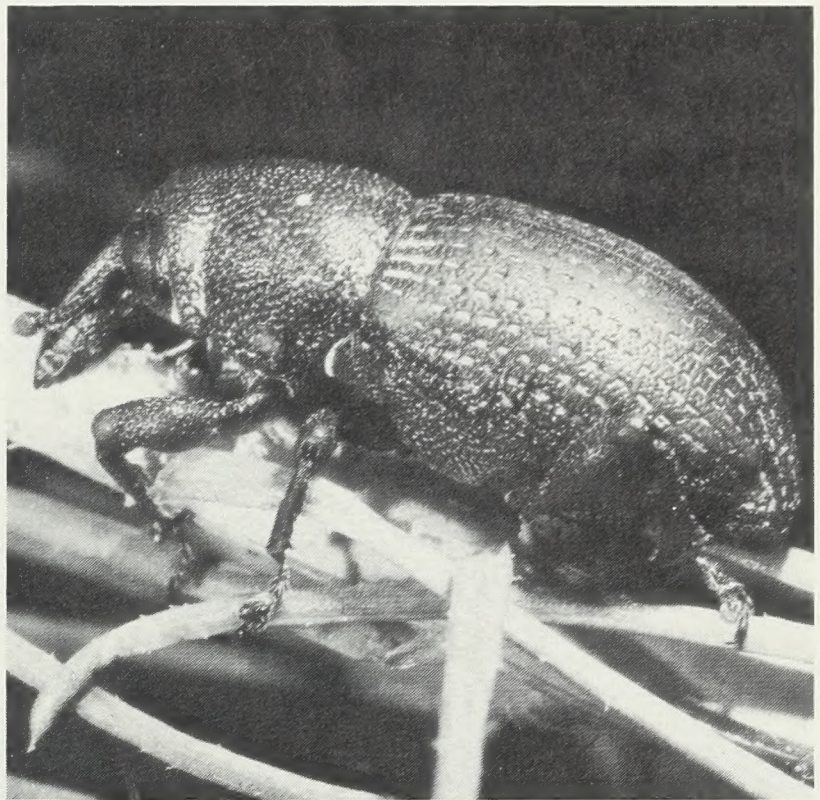


Figure 1.—Pales weevil adult. Figure 2.—Pitch-eating weevil adult.

In the South, the pales weevil and pitch-eating weevil are considered the most serious insect pests of first-year pine plantations growing on recently cutover sites. Seedling mortality from weevil feeding has been recorded as high as 90 percent, and 30 to 60 percent mortality is not uncommon.

This publication reviews current cultural and chemical methods of controlling these insects.

HISTORICAL BACKGROUND

Although the pales weevil was first described by J. F. W. Herbst in 1797, it was not considered an important forest pest until 1915, when it was responsible for a 70 percent loss in a white pine plantation on the Harvard Forest in Petersham, Mass. The first reported pales weevil damage in the South was in 1943. The weevils seriously damaged loblolly and shortleaf pine reproduction in recently cutover areas in the North Carolina piedmont. The pitch-eating weevil was not reported as an important pest of pine seedlings until the mid-1950's.

RANGE AND HOSTS

The range of pales and pitch-eating weevils covers most of the eastern United States and southeastern Canada. The pales weevil is the more common of the two species in northern areas and in the Atlantic Coastal States down to north Florida, whereas pitch-eating weevil is more common along the Gulf Coast. The ratio of pales to pitch-eating weevils ranges from 11:1 in the Southern Appalachians to 2-3:1 on Piedmont and Atlantic Coastal sites. Along the Gulf Coast, the ratio of pales to pitch-eating weevils ranges from 1:10 in southern Alabama to 1:6 in east Texas. These ratios, which are based on annual trap counts, may vary considerably from season to season.

Pales weevil adults feed upon most native and exotic coniferous species, including the following genera: *Pinus*, *Abies*, *Picea*, *Pseudotsuga*, *Larix*, *Thuja*, *Tsuga* and *Juniperus*.

The pitch-eating weevil may feed on many coniferous species, as does the pales weevil. However, it has been reported in the literature only on several of the southern pines.

BIOLOGY

Pales weevil adults are large beetles (7 to 12 mm; 0.3 to 0.5 inch long), and are dark reddish-brown with scattered patches of long, yellow-white hairs on the wing covers (figure 1). The pitch-eating weevil is about the same length as the pales weevil, but it is more robust and it appears darker because the hairs on its wing covers are sparser and shorter (figure 2). The pitch-eating weevil can also be distinguished by its widened hind leg; that of the pales weevil is slender.

Pitch-eating weevils are similar to pales weevils in their biology, behavior and seasonal occurrence. Adults of both species are attracted to areas where pines have recently been cutover or killed by bark beetles, fire, or some other agent. Here they feed nocturnally on the inner bark of freshly cut slash and stumps. Later, after the logging residue or dead pines dry out, the insects feed on the inner bark of small twigs of residual pines and stems of small pine seedlings (figure 3).



Figure 3.—Pitch-eating weevils girdling loblolly pine seedling.

This feeding on seedlings may result in small isolated patches of bark missing near the base of the stem or may be extensive enough to girdle the stem. Often seedlings are totally stripped of stem bark and needles. Feeding below the root collar may occur, especially on seedlings planted in duff or having loosely packed roots. According to one report, pitch-eating weevils feed more extensively on the root than above it.

The immature stages of the pales and pitch-eating weevils are similar in appearance (figure 4). Eggs are usually laid in small niches chewed in the bark of subterranean parts of stumps and roots. The larva bores an irregular tunnel under the bark, scoring the wood more deeply than the phloem. After passing through 5 to 6 larval stages, the insect pupates in a shallow cell in the outer surface of the wood.

In the South, active adult pales and pitch-eating weevils are found all year round, usually within flying distance of any potential pine cutting area. Adult pales weevils begin to migrate into an area with the onset of cutting, with the probable excep-



Figure 4.—Pine root with adult, larva, and pupae (left to right) of pitch-eating weevil in pupal cells.

tion of areas harvested during the cooler months. In eastern North Carolina, egg laying, and thus perhaps even migration, were found to cease from November to February. Weevils probably migrate into winter cuts in the spring (figure 5).

In eastern North Carolina, new pales weevil adults emerge from stumps and roots 3 to 12 months after trees are cut. Emergence on pine sites cut before June occurs from late summer to mid fall of the same year. In pine cut in June, part of the population emerges in the fall and part the following May and June (figure 5).

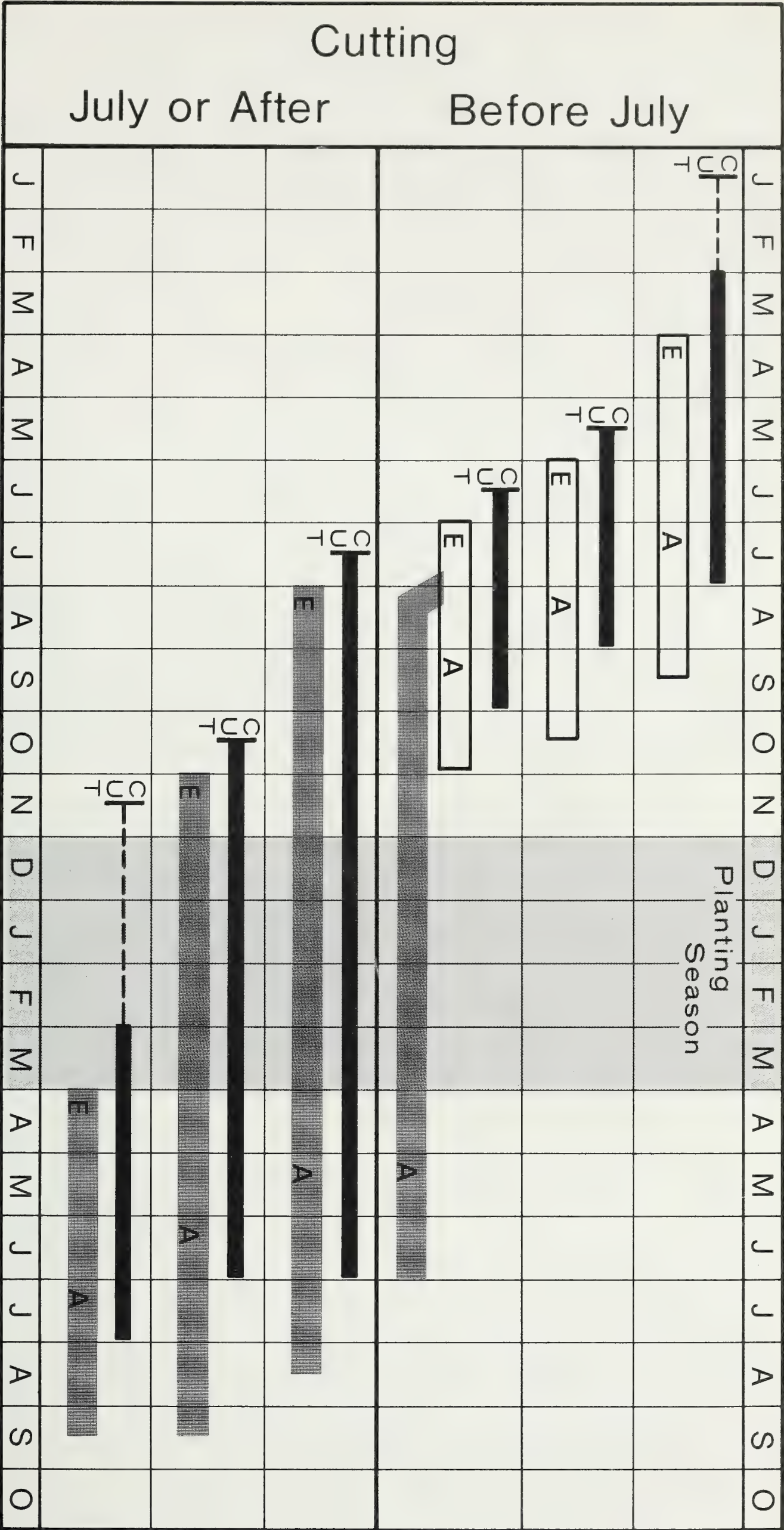
On sites cut in July or later, emergence occurs from May through August of the following year. A similar pattern of emergence for pitch-eating weevils, in relation to timing of cut, has been observed in east Texas.

Since serious weevil-caused seedling damage on the Atlantic and Gulf Coastal Plain occurs from February through May, before new adults emerge, this damage is caused by overwintering adults rather than new adults produced in the area. The weevils originally attracted into areas cut after June overwinter there. During warm periods, even in mid-winter, overwintering adults feed on pine seedlings and small pine twigs. Subsequent feeding in summer and fall is probably increasingly that of brood adults produced in the area.

Figure 5.—Adult migration and seasonal development of pales weevil in the North Carolina Coastal Plain as affected by time of harvest cut.

Cutting begins when indicated and lasts up to 2 weeks. The black bars indicate when adults migrate into stands cut at several different times of the year and how long they are present in the areas. Brood development depends on the time eggs are laid, which in turn, depends on the time of cutting. Brood from early eggs reach the adult stage from late summer to mid-fall (open bar), while brood from later eggs overwinter as larvae and emerge the second year (gray bar). **E** indicates when egg laying begins; **A** indicates when brood adults begin to emerge.

In areas cut before July, the brood which emerges by fall and any surviving parent adults (black bars) will migrate to fresh cuttings before the planting season (shaded area); therefore, feeding damage on seedlings does not occur. In areas cut in July or after, migrating parent adults remain in the area through the following winter and spring, causing seedling damage.



IDENTIFYING HAZARDOUS SITES

Weevil populations in the South tend to be high from year to year, and serious damage often occurs within a few days or weeks of planting, even in midwinter when the temperature moderates. Therefore, control decisions need to be made before planting. To make these decisions, the forest manager must be able to predict whether significant weevil-caused damage will occur on the site. The following sections provide guidelines for making that prediction for both species of weevils, and offer alternatives for controlling them. Most of the research on which these guidelines were based was done in areas where pales weevils were more common than pitch-eating weevils (i.e., eastern North Carolina, the Georgia Piedmont, southeastern Oklahoma, southwestern Arkansas). However, because of similarities in biology and behavior of the two species, and the good control obtained when using these guidelines in areas where both species occur, the guidelines apply to both species.

Hazard Rating

In the past, attempts have been made to correlate the number of pales weevils trapped on a site prior to planting with the subsequent seedling damage, in an effort to develop a pales weevil hazard rating system for recently cutover pine land. Pales and pitch-eating weevils are easily trapped in nature, and under favorable conditions large numbers may be collected. Various resin-containing materials can be used for trapping. The most commonly used materials are pine bolts about 18 inches (0.5 m) long, split once, or discs freshly cut from living pine stems 5 to 7 inches (13 to 18 cm) in diameter. Discs should be 1½ to 2 inches (4 to 5 cm) thick (figure 6). These traps are placed on the ground in an infested area, with the cut surface flush on the ground. Weevils are attracted to this material by the odor of the resin. The weevils crawl under the traps at night where they may remain for many hours (usually until mid-morning), feeding and mating. Correlations have been poor, however, between the numbers of weevils found trapped on planting sites prior to planting and subsequent seedling damage.



Figure 6.—Split pine bolt and pine discs placed around loblolly pine stump to trap pales and pitch-eating weevil adults.

Until a reliable hazard rating system is developed which can predict weevil damage based on weevil population estimates, forest managers must depend on other circumstantial evidence to determine if control is necessary.

Nonhazardous Sites

Weevil problems will not develop in certain planting situations, such as:

(1) Old fields and areas formerly covered with hardwoods, since weevils are not attracted to nonconiferous vegetation.

(2) Pine areas being regenerated by direct seeding, since weevils will have left the area before the seedlings are large enough to become suitable food.

(3) Pine areas cut and site-prepared before July, because weevils and their broods will either have died or migrated before the following planting season.

Hazardous Sites

Weevil damage is likely to occur on pine lands harvested in July or later and replanted the following winter. Note, however, that in sites cut prior to July, a late summer or fall site preparation which knocks down residual pine stems will result in another influx of weevils, and seedling mortality should be expected. The size of the attracted population and the amount of damage apparently depends on the volume of pine cut during site preparation.

Damage may also occur in areas cut in the spring or even in 1- to 3-year-old pine plantations adjacent to large freshly cut areas, but this damage is usually confined to 100-foot-wide border strips near the cutting. Seed tree cuts will also attract damaging populations of weevils. But by far, the most damage occurs in plantings on recently cutover or site-prepared pine lands.

Guide to Determining Weevil Damage Hazard

A rule of thumb has been developed for the Piedmont and Coastal Plain regions of the South that can be used by the forest manager to determine weevil hazard: *Pine lands cut and site prepared before July can generally be planted the following winter without control measures. However, on pine lands harvested in July and later, or in older cuttings where residual pine is cut during late summer or fall site preparation, planting should either be delayed one year or seedlings should be treated with insecticide to prevent weevil-caused mortality.*

This rule may not apply to pine sites in the southern Appalachians, where seedlings planted on sites cut before July would probably sustain damage.

CONTROL ALTERNATIVES

Delayed Planting

If planting on recently cut pine lands is delayed one year, weevil-caused damage will not occur. Although the delay easily solves the weevil problem, can you afford to allow land to lie idle for one year? The real cost of delayed planting versus other alternatives should be carefully evaluated.

A decision to replant high hazard areas at the first opportunity assumes that the present value of the timber gained through immediate regeneration is greater than the present value of the control cost. The value of this extra year's growth—and thus the cost of the delay—increases as site productivity, intensity of management, and product value increase. Therefore, investment in control is more profitable for intensively managed sawtimber stands on good sites than for pulpwood stands on poor sites. Other factors to consider are: the discount rate used for investment analysis, the length of time the costs must be carried, and tax treatment of control costs.

In some areas of the lower Coastal Plain, on sites cut in the fall and early winter, replanting usually must be delayed one year for silvicultural reasons. Completion of site preparation may not be possible until the following spring or summer, when the soil moisture drops. Therefore, planting cannot be done until the next winter. In those areas, weevils present no problem as long as site preparation, which might fell additional pines, is completed before July.

Chemical Control

If delayed planting is not required for silvicultural reasons or is economically unacceptable to the forest manager, chemical control applied at the time of planting is recommended to ensure successful regeneration of recently cut pine lands. Seedlings are usually treated with an insecticide at planting time, because feeding by weevils often begins soon after the seedlings are planted, especially if the night temperature is above 60° F.

A wait-and-see strategy is possible, and treatment can be delayed until damage begins to look serious. However, this requires weekly surveillance of the plantation and the capability to react swiftly with treatment, since severe feeding injury may

occur within a 1- to 2-week period when weevil populations are high.

Four treatments are currently registered for control of pales and pitch-eating weevils: (1) top dip of Imidan, (2) Furadan granules placed around the base of the seedling or in the planting hole, (3) Furadan-clay slurry root dip, and (4) Dursban spray.⁴ Details concerning treatment, operational procedures, precautions, and safety are given in the Appendix.

Chemical Control Strategy

A chemical control strategy for pales and pitch-eating weevils has been developed. Land is first assigned a hazard rating based on logging and site-preparation dates. "Cold" areas, which have a low hazard rating, are those cut in the late winter and spring and site-prepared during the spring or early summer. No weevil damage would be expected there. "Warm" areas, which have a moderate hazard rating, are those cut in the summer (July and after) and site-prepared in the summer and fall. Light to moderately heavy weevil damage would be expected. "Hot" areas, which have a high hazard rating, are those cut and site-prepared in the fall. Moderate to heavy weevil damage would be expected.

This hazard rating and control strategy is summarized in table 1. Planting time and control vary with the hazard rating. "Cold" areas could be planted any time. However, since planting "warm" and "hot" areas should be delayed as long as possible into the planting season to minimize seedling exposure to weevils and weathering of insecticide deposits, "cold" areas should be planted first, from December to mid-February. "Warm" and "hot" areas should be planted from mid-February through March.

Furadan granules should remain effective for 3 months or longer, so this treatment can be used in "warm" or "hot" areas planted as early as mid-February. But on sites where heavy feeding is likely immediately following planting, because of warm night temperatures (above 60°F), Dursban or Imidan would be recommended over Furadan granules. Because Furadan is a systemic insecticide requiring a good rain and

⁴Although it is not registered as a post-planting spray, Imidan could also be legally used in this manner.

Table 1.—Pales and pitch-eating weevil hazard rating for pine lands, based on logging and site-preparation dates, with recommended control.

Cutting History		Hazard Rating	Control Recommendation	
Logging date	Site-preparation date	—	Planting date	Treatment
winter-spring	spring to early summer ¹	cold (low)	December to mid-Feb.	None
summer	summer-fall	warm (moderate)	mid-Feb. through March	Furadan granules Imidan 50W+ extender Dursban 4E
			March	Furadan 4F
fall	fall	hot (high)	mid-Feb. through March	Furadan granules Imidan 50W+ extender Dursban 4E
—	—	(unexpected damage)	—	Dursban 4E Imidan 50W+ extender (sprays)

¹In a winter-spring cutting area, late summer and fall site preparation that kills residual pine may attract a damaging population of weevils, thus necessitating treatment.

some time to be drawn up into the seedling, heavy immediate feeding may not be prevented.

Since Dursban spray and Imidan top dip will usually last from mid-February through May, they can be used in early plantings. However, the Furadan-clay slurry root treatment usually does not last as long, and therefore is recommended only for March plantings on “warm” sites.

Weevil-caused mortality which is unexpected for any of several reasons should be of concern to forest managers. For example, a site may be incorrectly classified as “cold” due to errors in records for cutting or site-preparation dates. (It is important that actual cutting dates for the bulk of the harvesting be considered, not just the starting, ending, or contract dates.)

Possibly, because of unusual weather conditions or some site characteristic, damaging populations may be present in a June cutting area.

Furthermore, control obtained with all of the above insecticides has varied between sites, probably because of differences in weather conditions or weevil populations. Errors in mixing may occur, and quality of application varies. Therefore, monitoring weevil damage in treated—as well as untreated—plantations is strongly recommended, so that a remedial treatment can be applied in time to prevent loss. A Dursban or Imidan spray could be used in areas where unexpected weevil feeding occurs.

Preventing Large Population Buildups

Extremely large populations of weevils have occurred when large clearcuts were made adjacent to large areas clearcut the year before. In such areas, even treated seedlings have been overwhelmed by the insects. By reducing the size of clearcuts and spreading them out spatially, mortality has been reduced to an acceptable level among insecticide-treated seedlings. This practice spreads out the weevil population over a given area and prevents large populations of weevils from migrating enmasse only a short distance into a new cutting area where they can overwhelm seedlings.

APPENDIX

Chemical Control Alternatives

General Safety with Insecticides

The supervisor must explain to employees, in detail, how to handle insecticides and insecticide-treated seedlings in a safe manner. Employees must know what to do in case of an accidental contamination of skin and clothing or if symptoms of pesticide poisoning appear. The supervisor must not only provide this information, but make certain that employees work in a safe manner. The supervisor should stress the need to wash hands before eating, handling cigarettes or chewing tobacco, performing bodily functions, or before leaving the job. Wash basins, hand washing detergent, water, and towels must be provided at the job site. Torn gloves must be replaced immediately, and workers with blisters and open sores on hands must be given jobs that do not involve handling insecticides or treated seedlings.

Imidan Top Dip (Imidan 50W)

Treatment.—The tops of seedlings, down to and including the root collar, are dipped in an aqueous suspension of 4 percent active ingredient Imidan. An adjuvant—either Plantgard or Nu-film 17 mixed at 2.7 percent (14 ounces per 4 gallons, or 27 ml per liter) by volume—is optional, but recommended in “hot” areas or if high rainfall is expected. (Imidan can also be used as a post-planting spray. See information under Dursban Spray.)

Operational procedures.—Dip seedlings in loose bunches in the suspension for 10 to 15 seconds, ensuring good coverage of the lower stem (figure 7). Dipping can be done at the nursery prior to packing seedlings or at the planting site prior to planting.

Precautions.—Dip must be freshly mixed daily. Do not let it stand overnight. Agitate the dip frequently to keep the wett-able powder in suspension.



Figure 7.—Pine seedlings may be dipped at the nursery prior to packing or in the field prior to planting.

Seedlings must be dipped in loose bundles. Dipping whole, tightly packed, open-ended bundles of 500 to 1,000 seedlings is not recommended because the insecticide will not penetrate

and coat the entire lower stem of all the seedlings. The effect of Imidan on the root system has not been determined, so avoid covering roots with this insecticide.

Roots may dry excessively when seedlings are dipped at field sites. Therefore, dip in the early morning, before wind and temperature increase. Treated seedlings should be heeled-in or returned to a moist atmosphere in polybags or bundles as soon as possible.

Hand planters can use either planting bags or planting buckets. Water in planting buckets must not go above the root collar. Disposable polyethylene bag inner liners could be used in buckets and bags to prevent a buildup of insecticide.

Safety.—During the mixing of Imidan 50W, a respirator, goggles, liquid-proof coveralls or apron, rubber boots and rubber gloves must be worn. Imidan 50W is a wettable powder which should be wetted thoroughly with a small amount of water to make a slurry before adding the total amount of water. The powder will puff up out of the container and be carried by the slightest breeze during this operation, so it is imperative that a respirator and goggles be worn during mixing, and that other workers stay well away from and upwind of the mixing site.

During the dipping operation, a face shield should be worn to protect the eyes and face from splashing. Rubber gloves, apron or liquid-proof coveralls and rubber boots should also be worn.

Immediately after dipping the seedlings—whether in the nursery or in the field—place them on a tray or shallow container to catch the excess insecticide. This will prevent a buildup of toxic wastes in the area and the excess dip can be reused. Catch additional drippings with a disposable absorbent. When Imidan dip is spilled on nursery work tables and floors and allowed to dry, a dusty toxic residue results. This type of residue should be prevented because it might be inhaled. Planters should wear rubber gloves.

Furadan Granules

Treatment.—At planting time, broadcast Furadan granules (10 grams or 1 teaspoon for 10G; 7 grams or $\frac{3}{4}$ teaspoonful for 15G) in a 6-inch (15 cm) radius circle around the base of the seedling. Cover the granules with a light layer of soil or incorporate them into the soil. You may also apply granules in the planting hole at a reduced rate of 2 to 3 grams of 10G (1.3 to 2.0 g of 15G).

Operational procedure.—The granules can be applied by the planter or a second worker who is following behind. The granules can be applied with a scoop or metered out by an applicator attached to the planting bar (figure 8). A granule applicator on a planting machine could be devised.

Precautions.—Granular Furadan at rates higher than the recommended dosage can burn the foliage and even stop growth. Therefore, take care to apply the correct amount. *Do not exceed 10 grams of 10G (7 grams of 15G) per seedling when broadcasting.* Brown tips on old and first flush foliage may occur with the above rate of Furadan, but this is not serious and it will not affect growth rate or survival. If Furadan is placed in the planting hole, no more than 3 grams of 10G (2 grams of 15G) should be applied to prevent harmful effects. Test planting hole treatment on a small scale in order to check out any damage to the seedlings under local soil and climatic conditions.

Safety.—Open the bags and load granule reservoirs in an open, well-ventilated place. Take care not to inhale any Furadan dust. Persons handling and applying the granules should wear rubber gloves and goggles. Dispose of empty bags in a proper manner.

Furadan Root Dip (Furadan 4 Flowable)

Treatment.—Dip or spray seedling roots with a kaolin clay-water slurry containing 1 percent active ingredient Furadan flowable formulation.

Operational procedure.—The roots of the seedlings can be dipped or sprayed prior to bundling or bagging at the nursery, or they can be sprayed in the polybag. Dipping can be done in the field before planting. Under normal cold storage, Furadan should remain stable.



Figure 8.—Granule dispenser attached to the planting bar for surface or in-hole application of Furadan granules.

Precautions.—The Furadan-clay slurry suspension can be used for 2 to 3 days if the pH is 7 or below. The insecticide will break down more rapidly if the pH is greater than 7. Agitate the suspension thoroughly if it is held overnight; also stir it

frequently during the day. When seedlings are dipped at field sites, be sure the roots do not dry out. (See "Precautions" under Imidan Top Dip). In hand planting operations, planters should use planting bags instead of buckets so the insecticide is not washed off the roots. Polyethylene bags can be used as disposable inner liners to prevent contamination of planting bags.

Safety. When treating seedlings at the nursery, take care to contain the slurry and prevent spills. Spray the roots inside the polybags. Use low pressure to avoid fine droplets, which could be inhaled. If roots are dipped, be sure that the excess slurry drains back into the dipping tank or is absorbed by material in the bundle or polybag or material which can be disposed of periodically without contaminating work tables or the floor. Any spillage that is allowed to dry on nursery floors or work tables will lead to a dusty toxic residue that might be inhaled later. Workers exposed during the application and handling operation must wear face shields, liquid-proof coveralls, rubber gloves, and rubber boots.

Persons handling treated seedlings during the planting must wear rubber gloves and face shields. Take care to prevent spattering of the slurry by disentangling roots before placing seedlings in planting bags or bins of planting machines. Used seedling bags should be disposed of in a proper manner.

Dursban Spray (Dursban 4E)

Treatment.—Spray the stems of seedlings to the point of runoff after planting, with a 2-percent active ingredient aqueous spray.

Operational procedure. —Spray seedlings with low pressure back-pack sprayers (figure 9).

Safety.—Workers should wear liquid-proof coveralls or aprons, rubber boots, goggles, and respirators when mixing spray. They should wear rubber boots and rubber gloves and stand upwind while spraying.



Figure 9.—Backpack sprayer for post-planting treatment of seedlings with Dursban or Imidan.

REFERENCES

- Beal, J. A.; McClintick, K. B. The pales weevil in southern pines. J. Econ. Entomol. 36:792-794; 1943.
- Bullard, A. T. The habits and life history of the pitch-eating weevil, *Pachylobius picivorus* Germar, in the South Carolina piedmont. Clemson: Clemson University; 1968. 47 p. Thesis.
- Carter, E. E. *Hylobius* pales as a factor in the reproduction of conifers in New England. Proc. Soc. Am. For. 11:297-307; 1916.
- Ciesla, W. M.; Franklin, R. T. A method for collecting adults of the pales weevil, *Hylobius pales*, and the pitch eating weevil, *Pachylobius picivorus* (Coleoptera: Curculionidae). J. Kans. Entomol. Soc. 38:205-206; 1965.
- Doggett, C. A.; Grady, C. R.; Green, H. J. (and others). Seedling debarking weevils in North Carolina. For. Note No. 31. Raleigh, N.C.: Department of Natural and Economic Resources, North Carolina Forest Service; 1977. 15 p.
- Douglass, H. B. The seasonal history of the pine reproduction weevils, *Hylobius pales* (Herbst) and *Pachylobius picivorus* (Germar), on the South Carolina coast. Clemson: Clemson University; 1971. 49 p. Thesis.
- Franklin, R. T.; Taylor, J. W., Jr. Biology of *Pachylobius picivorus* (Coleoptera: Curculionidae) in the Georgia Piedmont. Can. Entomol. 102:962-968; 1970.
- Frazier, D. H. The pales weevil, *Hylobius pales* (Herbst), in Virginia: Damage and control. Blacksburg: Virginia Polytechnic Institute; 1969. 56 p. Thesis.
- Germar, E. F. Insectorum species novae aut minus cognitae, descriptionibus illustratae. Halae: J. C. Hendelii; 1824; 311. 624 p.
- Hedden, R. Economics of seedling debarking weevil control. In: Proceedings of the twenty-fourth southern forest insect work conference; 1979 August 13-16; Lexington, Ky; 1979:17. Available from: USDA Forest Service Forest Pest Management Staff, 2500 Shreveport Highway, Pineville, La.
- Herbst, J. F. W. Natursystem aller bekannten in- und ausländischen Insecten, als eine Fortsetzung der von Buffonschen Naturgeschichte. Der Kafer. Berlin: Joachim Pauli, 1797; 31. 346 p. vol. 7 of 10 vol. 1785-1806.

- Hyche, L. L. Population studies on the pine reproduction weevils, *Hylobius pales* (Herbst), and *Pachylobius picivorus* (Germar) Ann. Rep. Auburn, Ala.: Alabama Agric. Exp. Stn.; 1959. p. 329-333.
- Jackson, L. W. R.; Thompson, G. E.; Lund, H. O. Forest diseases and insects of Georgia's trees. Macon: Georgia Forestry Commission; 1955. 40 p.
- Lawrence, L. K. Relationship between number of pales weevils trapped and subsequent seedling mortality. For. Note No. 23. Raleigh: Department of Natural and Economic Resources, North Carolina Forest Service; 1975. 5 p.
- Neidhardt, K. F. E. Ecology and behavior of two pine reproduction weevils, *Hylobius pales* (Herbst) and *Pachylobius picivorus* (Germar) (Coleoptera: Curculionidae), in Alabama. Auburn: Auburn University; 1969. 75 p. Thesis.
- Nord, J. C.; Flavell, T. H.; Pepper, W. D. (and others). Field test of chlorpyrifos and carbofuran to control weevils that debark pine seedlings. Res. Note SE-226. Asheville, N.C.: USDA Forest Service, Southeastern Forest Experiment Station; 1975. 7 p.
- Nord, J. C.; Flavell, T. H.; Pepper, W. D. (and others). Field test of four insecticides for control of pales and pitch-eating weevils in first-year pine plantations. Res. Note SE-255. Asheville, N.C.: USDA Forest Service, Southeastern Forest Experiment Station; 1978. 9 p.
- Peirson, H. B. The life history and control of the pales weevil (*Hylobius pales*). Harvard For. Bull. 3; 1921. 33 p.
- Sentell, N. W. Pales weevil damages plantations in Louisiana. J. For. 47:741; 1949.
- Speers, C. F.; Ebel, B. H. Pales and pitch-eating weevils: ratio and period of attack in the South. Res. Note SE-156. Asheville, N.C.: USDA Forest Service, Southeastern Forest Experiment Station; 1971. 5 p.
- Speers, C. F. Pales and pitch-eating weevils: development in relation to time pines are cut in the Southeast. Res. Note SE-207. Asheville, N.C.: USDA Forest Service, Southeastern Forest Experiment Station; 1974. 7 p.
- Speers, C. F.; Merkel, E. P. How to prevent weevil damage to pine seedlings in the South. Gen. Tech. Rep. SE-5. Asheville, N.C.: USDA Forest Service, Southeastern Forest Experiment Station; 1974.
- Taylor, J. W. Jr.; Franklin, R. T. Biology of *Hylobius pales*

- (Coleoptera; Curculionidae) in the Georgia Piedmont. Can. Entomol. 102:729-735; 1970.
- Thatcher, R. C. Pine reproduction weevils: preliminary results from 1955-1957 studies. Southern Forest Pest Reporter No. 18. New Orleans, La.: USDA Forest Service, Southern Forest Experiment Station; 1957. 2 p.
- Thatcher, R. C. Influence of the pitch-eating weevil on pine regeneration in east Texas. For. Sci. 6:354-361; 1960.
- Thomas, H. A.; Hertel, G. D. Responses of the pales weevil to natural and synthetic host attractants. J. Econ. Entomol. 62:383-386; 1969.
- Walstad, J. D. New strategies for controlling pales weevil in pine plantations of the southern USA. *In*: Proceedings of the 16th International Union of Forest Research Organizations World Congress; 1976 June 20 - July 2; Oslo, Norway; 1976:459-466.
- Walstad, J. D.; Hart, J. B., Jr.; Cade, S. C. Carbofuran-clay root dip protects loblolly pine seedlings from debarking weevils. J. Econ. Entomol. 66:1219-1220; 1973.
- Walstad, J. D.; Nord, J. C. Applied aspects of pales weevil control. Down to Earth 31:8-12; 1975.

The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

CAUTION

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key — out of the reach of children and animals — and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed them. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your State forestry agency, county agricultural agent or State extension specialist to be sure the intended use is still registered.



Use Pesticides Safely
FOLLOW THE LABEL

U.S. DEPARTMENT OF AGRICULTURE